

METHOD AND DEVICE FOR DETECTING THE SPEED OF A PUMP

Field of the Invention

The present invention relates to a method and a system for detecting the speed of a pump motor.

5

Background Information

10

It is known in the art to determine the speed of a pump motor using dedicated speed sensors. Given a clocked operation of a pump motor, the speed of the pump motor may also be ascertained, in the undriven phase, on the basis of the generating voltage of the pump motor. Such methods are used in the regulation of the pump motor within the framework of an electrohydraulic braking system, for example.

15

20

German Patent 41 33 269 describes a method for measuring the speed of a rotating part surrounded by a housing, in which a further signal that is a function of the speed is detected, and this further signal is filtered and digitalized, as well as Fourier-transformed twice. The speed is ascertained from the spectrum thus obtained, by evaluating the absolute maximum. A relatively great computing power is necessary to implement such a speed measurement because of the Fourier analysis used.

25

In general, known methods for detecting the speed of motors, particularly pump motors, tend to be relatively

costly.

Summary of the Invention

5 The present invention provide a method and a system for
detecting the speed of a pump motor as simply and
inexpensively as possible, by determining the pressure
peaks within the pressure signal representing the
10 delivery activity of the pump. In accordance with the
present invention, the start-up of a pump motor may be
reliably monitored, for example. The detection method
according to the present invention universally
applicable, i.e., independent of the type and the driving
of the pump motor.

15 The detection method according to the present invention
requires no correction to compensate for the temperature
factor, and the method is substantially robust with
respect to disturbing reflections between a pump and a
20 reservoir acted upon by the pump.

In accordance with the present invention, it is
advantageous to filter out high-frequency interferences
in the pressure signal caused by the driven pump, using
25 suitable filtering means. Similarly, it is advantageous
to filter out low-frequency interferences in the pressure
signal, particularly a DC voltage component, which stems
from the rising pressure in the reservoir acted upon by
the pump. A pressure signal that has been filtered of
30 high- frequency and/or low-frequency interferences, may
be further processed in a simple manner.

The pressure signal, particularly the filtered pressure
signal, may be shaped by means of a comparator circuit

to obtain a square-wave signal whose frequency is proportional to the speed of the pump motor. A square-wave signal thus obtained may be readily evaluated by calculation.

5

To implement the filters mentioned, suitable filtering means, e.g., a low-pass filter or a high-pass filter, may be used. Such filters may be made available inexpensively.

10

Brief Description of the Drawings

Figure 1 shows a time graph illustrating the pressure characteristic in a pressure system acted upon by a pressure pump.

15

Figure 2 shows a graph illustrating the spectral view of the pressure signal shown in Figure 1.

Figure 3 shows a block diagram illustrating the filtering of the pressure signal shown in Figure 1, in accordance with the present invention.

20

Figure 4 shows a filtered time signal in accordance with the present invention, which signal is obtained after the filtering in accordance with Figure 3.

25

Figure 5 shows a square-wave signal obtained after the signal shown in Figure 4 has been further processed by a comparator.

30

Figure 6 shows a schematic block diagram of an example embodiment of the device according to the present invention.

Detailed Description

5 In a hydraulic pump system, a pump is driven by a pump motor to deliver a hydraulic fluid, via a pressure-media line, into a high-pressure reservoir. During this delivery, pressure peaks develop within the framework of a pressure signal in the pressure-media line and/or in the high-pressure reservoir, the time interval between the pressure peaks being a measure of the speed of the pump motor. The pressure signal is detected by a suitable sensor and converted into a corresponding current signal or voltage signal. A signal of this type, after an optional digitalization, is further processed in a computing device.

10 A schematic representation of a hydraulic pump system in accordance with the present invention is shown in Figure 6. Here, 60 designates a pump motor which drives a pump 62. Pump 62 in turn delivers hydraulic fluid via a hydraulic line 64 into a high-pressure reservoir 66. The pressure created in this high-pressure reservoir is detected by a pressure sensor 68 to obtain a pressure signal representing the pump activity, and the pressure signal is optionally converted into a corresponding electrical signal and digitalized. A signal of this type is supplied to a computing device 70, in which the further evaluation of the signal may be carried out.

15 As shown in Fig. 1, the pressure signal p determined in the high-pressure reservoir 66, e.g., the voltage signal representing the pressure in the reservoir, is superimposed with high-frequency interferences due to reflections between the pump output and the high-pressure reservoir. Also superimposed on the signal is a DC

voltage component stemming from the rising pressure in the reservoir 66 because of the action of the pump on the reservoir.

5 As shown in Fig. 2, which shows a spectral view of the signal shown in Figure 1, the pressure signal p is plotted against frequency f . The DC-voltage component of the pressure signal is designated here by 1, and the high-frequency interference component of the signal is
10 designated by 2. The useful component of the signal, i.e., the component of the pressure signal actually used in the method according to the present invention, is provided with reference numeral 3.

15 As shown in Fig. 3, pressure signal p is first supplied to a low-pass filter 10 having a suitable cut-off frequency, which suppresses interfering high-frequency component 2 of the pressure signal. Subsequently, in a second step, the signal is conducted through a high-pass
20 filter 12 having a suitable cut-off frequency, which filter suppresses the DC voltage component 1. Signal p' emerging from the high-pass filter represents a filtered time signal whose time characteristic is shown in Figure 4. The curves of filters 10, 12 are represented by
25 dotted lines in Figure 2.

Signal p' is supplied to a comparator circuit 13, which outputs a square-wave signal p'' whose frequency is proportional to the speed of pump motor 60. A square-wave
30 signal p'' of this type is shown in Figure 5, plotted against time. The period length of the signal is designated by T , and the respective period beginnings are designated by t_0 , t_1 , t_2 , etc. Frequency f , proportional to the pump motor speed, is yielded from $f = 1/T$. The

actual speed of pump motor 60 may be inferred directly by
suitable normalization.